(54) METHOD FOR ALLOCATING RADIO CHANNEL FOR RADIO COMMUNICATION

(57) In carrying out radio communication between one base station and a plurality of radio terminals in its radio zone, the number of channels, the number of slots, the frequency band or similar channel factor is changed in accordance with the amount of communication data or the rate of change of the amount of communication data per unit time, by which it is possible to speed up data communication and reduce inefficient use of channels through effective utilization of a limited number of channels.

FIG.1
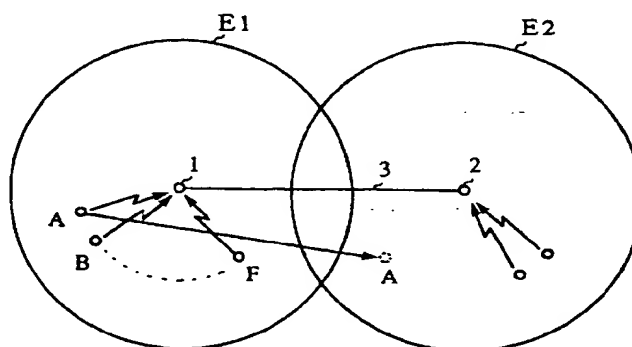
EP 0 977 377 A1

Description

TECHNICAL FIELD

[0001]   The present invention relates to a method of radio channel assignment for radio communications between one base station and a plurality of radio terminals which are in its radio zone, such as portable radiotelephones, cordless telephones and personal handy phones (PHS).

BACKGROUND ART

[0002]   Fig. 1 is a diagrammatic showing of the configuration of a conventional communication network system, in which base stations 1 and 2 of radio zones respectively E1 and E2 are interconnected through a public switched telephone network 3. Radio terminals A to F in radio zone E1 communicate with the base station 1, for example, by frequency division multiple access (FDMA) or time division multiple access (TDMA).

[0003]   In this instance, when radio terminals A to F are used as ordinary telephones, the amount of data for communication (hereafter communication data) is constant, and hence they need only to be assigned a radio channel of a fixed channel capacity. However during data communication, the amount of communication data increases or decreases according to the state of access. When the amount of communication data increases, if such channel capacity factors as the number of channels and slots and the frequency bandwidth remain unchanged despite an increased amount of data, resources run short which results in a failure to achieve a satisfactory transmission speed. On the contrary, when the amount of communication data decreases, the degree of unused resources increases and radio channels are not effectively used.

[0004]   To overcome the above drawbacks, a method has been proposed which employs small-capacity and large-capacity radio channels each provided separately and selectively switches them according to the amount of communication data as disclosed, for example, in Pat. Appln. Laid-Open Gazette No. 97824/96.

[0005]   However, when the number of communication terminals that use only the small-capacity radio channels is larger than the total number of small-capacity radio channels, some of the communication terminals cannot be assigned radio channels. Furthermore the assignment of large-capacity radio channels to such communication terminals will inevitably give arise to a problem of ineffective use of radio channels.

[0006]   The present invention is intended to solve the above problem, and has the object of increasing the speed of data communication and reducing waste in the use of radio channels through the effective utilization of a limited number of channels on the basis of changing the number of channels, the number of slots, the frequency bandwidth, or similar channel factors in accordance with the amount of communication data or the rate of change in the amount of communication data per unit time.

DISCLOSURE OF THE INVENTION

[0007]   According to an aspect of the present invention, in a radio channel assignment method for radio communication between a base station and a plurality of radio terminals in its radio zone, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by increasing or decreasing the number of radio channels in accordance with the amount of communication data between the base station and each radio terminal.

[0008]   According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by decreasing the number of radio channels when the amount of communication data is smaller than a preset reference value, and by assigning a plurality of radio channels to the radio terminal concerned when the amount of communication data is larger than a preset reference value.

[0009]   According to another aspect of the present invention, it is possible to speed up data communication by assigning a plurality of consecutive available radio channels to the radio terminal concerned when the amount of communication data is larger than a preset reference value.

[0010]   According to another aspect of the present invention, it is possible to speed up the data communication by sending a radio channel assignment message from the base station to the radio terminal concerned in order to change the radio channel assigned thereto to a plurality of consecutive available radio channels.

[0011]   According to another aspect of the present invention, it is possible to speed up the data communication by sending a radio channel assignment message from the radio terminal concerned to the base station in order to change the radio channel assigned so far to a plurality of consecutive available radio channels.

[0012]   According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by assigning with a new radio channel to a radio terminal assigned a radio channel which is one of a plurality of consecutive available radio channels required for another radio terminal.

[0013]   According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by sending a radio channel assignment request message from the base station to a radio terminal assigned with a

radio channel which is one of a plurality of consecutive available radio channels required for another radio terminal and by assigning a different radio channel to the radio terminal concerned.

[0014] According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by sending a radio channel assignment request message from the a radio terminal concerned to the base station, by sending thereto a radio channel assignment message to the radio terminal assigned with a radio channel required by another radio terminal, and by assigning a different radio channel to the radio terminal concerned.

[0015] According to another aspect of the present invention, it is possible to increase the number of terminals that can be simultaneously connected to the base station, by decreasing the number of channels assigned per terminal through effective utilization of a limited number of radio channels. This is achieved by decreasing the number of radio channels assigned to a radio terminal to make one of them unassigned when a radio terminal is newly connected to the base station.

[0016] According to another aspect of the present invention, it is possible to reduce inefficient use of radio channels through effective utilization of a limited number of radio channels by assigning a radio channel, made unassigned by changing the radio channel assignment, to a radio terminal required to carry out communication over a plurality of radio channels.

[0017] According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by providing frequency division multiple access channels between the radio terminals and the base station.

[0018] According to another aspect of the present invention, it is possible to speed up data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by the provision of time division multiple access channels between the radio terminals and the base station.

[0019] According to another aspect of the present invention, in a radio channel assignment method for radio communications between a base station and a plurality of radio terminals in its radio zone, it is possible to speed up the data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by determining the number of radio channels to be assigned, by the base station, in accordance with the rate of change of the amount of stored data per unit time.

[0020] According to another aspect of the present invention, in a radio channel assignment method for radio communications between a base station and a plurality of radio terminals in the radio zone of the base station, it is possible to speed up the data communication and reduce inefficient use of radio channels through

effective use of a limited number of radio channels by determining the number of radio channels to be assigned, by each radio terminal, in accordance with the rate of change of the amount of stored data per unit time.

[0021] According to still another aspect of the present invention, in a radio channel assignment method for radio communication between a base station and a plurality of radio terminals staying in the radio zone of the base station, it is possible to speed up the data communication and reduce inefficient use of radio channels through effective use of a limited number of radio channels by sending, upon occurrence of a hand-over, the number of assigned channels to a base station with which the radio terminal newly communicates.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Fig. 1 is a diagram illustrating a communication network system; Fig. 2 is a block diagram depicting the configuration of a radio communication system in which a plurality of radio terminals communicate with one base station by frequency division multiple access (FDMA); Fig. 3 is an explanatory diagram of variation in radio channel assignment when the amount of communication data is larger than a preset threshold; Fig. 4 is an explanatory diagram of the variation in the radio channel assignment when the amount of communication data is smaller than the preset threshold; Fig. 5 is an explanatory diagram of the variation in radio channel assignment when a terminal C, which uses a plurality of channels, hops; Fig. 6 is an explanatory diagram of variation in radio channel assignment when a terminal adjacent the terminal C, which uses a plurality of channels, hops; Fig. 7 is an explanatory diagram of variation in radio channel assignment in the absence of available channels; Fig. 8 is an explanatory diagram of variation in radio channel assignment when fragmented channels are gathered together; Fig. 9 is a block diagram illustrating the configuration of a radio communication system in which a plurality of radio terminals communicate with one base station by time division multiple access (TDMA); Fig. 10 is an explanatory diagram of variation in radio channel assignment when the amount of communication data is larger than a preset threshold; Fig. 11 is an explanatory diagram of variation in radio channel assignment when the amount of communication data is smaller than the preset threshold; Fig. 12 is an explanatory diagram of variation in radio channel assignment when a terminal C, which uses a plurality of slots, hops; Fig. 13 is an explanatory diagram of variation in radio channel assignment when a terminal adjacent the terminal C, which uses a plurality of slots, hops; Fig. 14 is an explanatory diagram of variation in radio channel assignment for decreasing the number of slots assigned to channel C down to one when no slots are available; Fig. 15 is an explanatory diagram of variation in radio channel assignment for assigning one of the

slots assigned to the terminal C to another terminal when no slots are available; Fig. 16 is an explanatory diagram of variation in radio channel assignment when fragmented channels are gathered together; Fig. 17 is a diagram showing a sequence for the radio terminal side to request the base station side to change the radio channel assignment; and Fig. 18 is a diagram showing a sequence for the base station side to request the radio terminal side to change the radio channel assignment.

BEST MODE FOR CARRYING OUT THE INVENTION

[0023]   To facilitate a better understanding of the present invention, a detailed description will be given, with reference to the accompanying drawings, of the best mode for carrying out the invention.

EMBODIMENT 1

[0024]   Fig. 2 is a block diagram depicting a radio communication system according to Embodiment 1 of the present invention in which a plurality of radio terminals A (5A) to F (5F) communicate with one base station 1 by frequency division multiple access (FDMA).
[0025]   The radio terminals A (5A) to F (5F) are each composed of: a buffer 11 for storing data to be sent; an amount-of-data monitor 12 for detecting the amount of data stored in the buffer 11, for example, in terms of software under program control; a controller 13 for controlling the radio terminal; a modulator 14 which performs modulation (changing the bandwidth) as determined by the controller 13; a transmitter 15; a demodulator 16; and a receiver 17.
[0026]   The base station 1 is provided with: individual base stations 1A to 1F corresponding to the radio terminals A (5A) to F (5F), respectively; a controller 4 for controlling the individual base stations 1A to 1F; and a channel assignment monitor 5 for monitoring the channel assignment of the base station 1.
[0027]   The individual base stations 1A to 1F are each made up of: a receiver 21; a demodulator 22; a buffer 23 for storing received data; an amount-of-data monitor 24 for detecting the amount of data stored in the buffer 23, for example, in terms of software under program control; a modulator 25; and a transmitter 26.
[0028]   Next, the operation of this embodiment will be described below.
[0029]   The radio terminal A (5A): stores communication data in the buffer 11; monitors the amount of data stored therein by the amount-of-data monitor 12; decides a required channel capacity for communication, by the controller 13 based on the result of monitoring; and sends a channel capacity change request message based on the decision result to the individual base station 1A via the modulator 14 from the transmitter 15.
[0030]   The individual base station 1A: demodulates the signal received by the receiver 21 with the demodulator 22; checks the demodulated data by the controller

4; determines whether or not to respond to an inquiry of the radio channel assignment request message from the radio terminal A (5A), based on the result of monitoring by the monitor 5; and sends the determination result from the controller 4 to the radio terminal A (5A) via the modulator 25 and the transmitter 26 of the individual base station 1A.
[0031]   Based on a radio channel assignment permission message sent from the individual base station 1A, the radio terminal A (5A) sends communication data from the buffer 11 by the transmitter 15 via the modulator 15 to the individual base station 1A.
[0032]   A description will be given below of varying the radio channel in response to a change in the amount of communication data.

1. When the amount of communication data is larger than a preset threshold:
    When a channel M+1 is set for the radio terminal A (5A) as depicted in Fig. 3(a), if the amount of communication data exceeds the channel capacity of the channel M+1, the radio terminal A (5A) requests the individual base station 1A to use, for example, channels M and M+2 adjacent the channel M+1 as shown in Fig. 3(b). On receiving permission from the individual base station 1, the radio terminal A (5A) sets the three adjoining channels for its use. Thus, even if the amount of communication data increases, no increase will be caused in the amount communication time.
2. When the amount of communication data is smaller than a preset threshold:
    When three channels M through M+2 are set as radio channels for the radio terminal A (5A) as depicted in Fig. 4(a), if the amount of communication data becomes smaller than the channel capacity of the channel M+1, the radio terminal A (5A) sends, to the individual base station 1A, a radio channel assignment request message to use only the channel M+1 as shown in Fig. 4(b). After receiving permission from the individual base station 1A the radio terminal uses that channel alone. Thus, even if the amount of communication data decreases, it is possible to continue communication without wasting channel capacity.
3. When a radio terminal C (5C not shown) that uses a plurality of channels hops:
    When the radio terminals A (5A) through D (5D) are assigned the channels M through M+3 as shown Fig. 5(a), if the amount of communication data from the radio terminal C (5C) becomes larger than the channel capacity of the channel M+2, the radio terminal C sends a channel assignment request message to the individual base station 1C (not shown) as depicted in Fig. 3(b). Upon receiving the channel assignment request message, the individual base station 1C requests a channel assignment from the controller 4. Based on the channel

assignment status stored in the channel assignment monitor 5, the controller 4 posts a plurality of consecutive channels N, N+1 and N+2 to the individual base station 1C, which, in turn, sends a channel assignment permission message to the radio terminal C to permit the use of the channels N, N+1 and N+2. Upon receiving the permission from the individual base station 1C, the radio terminal C sets the three channels for its use. Thus, even if the amount of communication data increases, it is possible to continue communication without affecting the adjoining channels and without causing an increase in the amount of communication time.

4. When a radio terminal adjacent the radio terminal C (5C) that uses a plurality of channels hops:

When the channels M through M+3 are set as radio channels for the radio terminals A (5A) through D (5D) as depicted in Fig. 6(a), if the amount of communication data from the radio terminal C (5C) becomes larger than the channel capacity of the channel M+2, the radio terminal C (5C) sends a channel assignment request message to the individual base station 1C (not shown) as depicted in Fig. 6(b). Upon receiving the channel assignment request message, the individual base station 1C requests a channel assignment from the controller 4. Based on the channel assignment status stored in the channel assignment monitor 5, the controller 4 instructs the individual base stations 1B and 1D to use channels N and N+1. The individual base stations 1B and 1D post, by a channel assignment permission message, to the radio terminals B and D the assignment thereto of the channels N and N+, respectively. The individual base station 1C posts, by a channel assignment permission message, to the radio terminal C the assignment thereto of the channels M, M+1 and M+2. Thus, even if the amount of communication data increases, it is possible to continue communication without affecting the adjoining channels and without causing an increase in the amount of communication time.

5. When no channels are available:

In the case where all the channels are set for the radio terminals A (5A) through f (5F) and no channels are available as depicted in Fig. 7(A), if a radio terminal G (5G, not shown) sends a radio channel assignment message to an individual base station 1G, then the controller 4 reduces the three channels set for the radio terminal C (5C) to one channel, and sets the one available channel N+1 as a radio terminal G (5G) and the other channel N+2 as an unassigned channel as shown in Fig. 7(b). As a result, although the transmission speed of the radio terminal C (5C) decreases, the radio terminal G (5G) can carry out communication.

6. Fragmented unassigned channels are gathered together:

When the channels M, M+2, N+1 and N+3 are set to the radio terminals A (5A), B (5B), C (5C) and D (5D), respectively, as shown in Fig. 8(a), the individual base stations 1B and 1D (not shown) send radio channel assignment messages to the radio terminal B (5B) and D (5D) to assign the channels M+1 and M+3, respectively, as depicted in Fig. 8(b). As a result, the unassigned channels can be gathered together without inhibiting communication.

EMBODIMENT 2

[0033] Fig. 9 is a block diagram illustrating the configuration of a radio communication system according to Embodiment 2 of the present invention in which a plurality of radio terminals communicate through a single base station by time division multiple access (TDMA). In Fig. 9, reference characters A (51A) to F (51F) denote radio terminals, and 52 a base station. The radio terminals A (51A) to F (51F) are each composed of: a buffer 61 for storing data to send; an amount-of-data monitor 62 for detecting the amount of data stored in the buffer 61, for example, in terms of software under program control; a controller 63 for controlling the radio terminal; a modulator 64; a transmitter 65; a demodulator 66; a receiver 67; a time-division transmitter 68 for determining transmission timing; and a time-division receiver 69 for determining reception timing.

[0034] The base station 52 comprises: individual base stations 52A to 52F correspond to the radio terminals A (51A) to F (51F), respectively; a controller 53 for controlling the individual base stations 52A to 52F; and a channel assignment monitor 54 for monitoring the channel assignment of the base station 52.

[0035] The individual base stations 52A to 52F are each made up of: a receiver 71; a demodulator 72; a buffer 73 for storing received data; an amount-of-data monitor 74 for detecting the amount of data stored in the buffer 73, for example, in terms of software under program control; a modulator 75; a transmitter 76; time-division receiver 77 for determining reception timing; and a time-division transmitter 78 for determining transmission timing.

[0036] Next, the operation of this embodiment will be described below.

[0037] The radio terminal A (51A): stores communication data in the buffer 61; monitors the amount of data stored therein by the amount-of-data monitor 62; decides a required channel capacity for communication, by the controller 63 based on the result of monitoring; and sends a channel capacity change request message based on the decision result to the base station 52 via the modulator 64 from the transmitter 65 at the transmission timing provided from the time-division transmitter 69.

[0038] The individual base station 52A uses the demodulator 22 to demodulate the signal received by the receiver 71 at the reception timing provided from the

time-division receiver 77. It checks the demodulated data by the controller 53, determines whether or not to respond to the radio channel assignment request message from the radio terminal A (51A), based on the result of monitoring by the monitor 54, and sends the determination result from the controller 53 of the base station 52 to the radio terminal A (51A) via the modulator 75 and the transmitter 76 of the individual base station 52A at the timing for transmission provided by the time-division transmitter 78.

[0039]   The radio terminal A (51A) receives the instruction signal from the individual base station 52A at the reception timing provided by the time-division receiver 67; and sends the communication data, stored in the buffer 61, via the modulator 64 to the base station 52A from the transmitter 65 over the radio channel instructed by the base station 52A.

[0040]   A description will be given below of the variation in the radio channel with a change in the amount of communication data.

7. When the amount of communication data is larger than a preset threshold:

When a slot S1 of a channel M is set as a radio channel for the radio terminal A (51A) as depicted in Fig. 10(a), if the amount of communication data becomes larger than the channel capacity of the slot S1 of the channel M, the radio terminal A (51A) sends a channel assignment request message to the individual base station 52A as shown in Fig. 10(b). Upon receiving the channel assignment request message, the individual base station 52A requests a channel assignment of the controller 53, and based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts a plurality of consecutive slots S1 to S3 of the channel M to the individual base station 52A; and the individual base station 52A posts the slots S1 to S3 of the channel M to the radio terminal A (51A) by a channel assignment permission message. Upon receiving the permission from the individual base station 52A, the radio terminal A (51A) uses the slots S1 to S3 for communication. Thus, even if the amount of communication data increases, the time for communication will not increase.

8. When the amount of communication data is smaller than a preset threshold:

When all the slots S1 to S3 of the channel M are set as a radio channel for the radio terminal A (51A) as depicted in Fig. 11(a), if the amount of communication data becomes smaller than the channel capacity of the slot S1, the radio terminal A (51A) sends a channel assignment request message to the individual base station 52A as shown in Fig. 11(b). Upon receiving the channel assignment request message, the individual base station 52A requests a channel assignment of the controller 53,

and based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts the slot S1 of the channel M containing a plurality of consecutive slots to the individual base station 52A; and the individual base station 52A posts the slot S1 the channel M to the radio terminal A (51A) by a channel assignment permission message. Upon receiving the permission from the individual base station 52A the radio terminal A (51A) uses the slot S1 for communication. Thus, even if the amount of communication data decreases, it is possible to continue communication without wasting channel capacity.

9. When the radio terminal C (51C) that uses a plurality of slots hops:

When all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and C (51C) and all slots of the channel M+1 are unassigned as shown Fig. 12(a), the radio terminal C (51C) sends a channel assignment request message to the individual base station 52C (not shown) as depicted in Fig. 12(b) on an increase in the amount of communication data. Upon receiving the channel assignment request message, the individual base station 52C requests a channel assignment of the controller 53. Based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts a plurality of consecutive slots S1 to S3 of the channel M+1 to the individual base station 52C. The individual base station 52C sends a channel assignment permission message to the radio terminal C (51C) to post thereto the slots S1 to S3 of the channel M+1. Upon receiving the permission from the individual base station 52C, the radio terminal C (51C) sets the three slots S1 to S3 for its use. Thus, even if the amount of communication data increases, it is possible to continue the communication without causing an increase in the amount of time for communication. In this instance, the slot S3 of the channel M becomes unassigned.

10. When a radio terminal adjacent the radio terminal C (51C) that uses a plurality of slots hops:

When all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and C (51C) and all the slots of the channel M+1 are unassigned as depicted in Fig. 13(a), the radio terminal C (51C) sends a channel assignment request message to the individual base station 1C (not shown) as depicted in Fig. 13(b). Upon receiving the channel assignment request message, the individual base station 52C requests a channel assignment of the controller 53. Based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts the slots S1 to S3 of the channel M to the individual base station 52C, the slot S1 of the channel M+1 to the individual base station 52A and the slot

S2 of the channel M+1 to the individual base station 52B as shown in Fig. 12(b). The individual base station 52 posts all the slots of the channel M to the radio terminal C (51C) by a channel assignment permission message. The individual base station 52 posts the slot S1 of the channel M+1 to the radio terminal A (51A) by a channel assignment permission message, and the individual base station 52 posts the slot S1 of the channel M+1 to the radio terminal B (51B) by a channel assignment permission message.

The radio terminal C (51C) is set to use all the slots of the channel M. And, the radio terminal A (51A) is set to use the slot S1 of the channel M+1, and the radio terminal B (51B) is set to use the slot S1 of the channel M+1. Thus, even if the amount of communication data increases, it is possible to continue the communication without causing an increase in the amount of time for communication.
11. When no channels are available (when one slot is assigned to the radio terminal C (51C)):

In the case where all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and D (51D) and all the slots S1 to S3 of the channel M+1 are set as a radio channel for the radio terminal C (51C) as depicted in Fig. 14(a), if a radio terminal E (51E, not shown) sends a radio channel assignment message, then an individual base station 52E requests a channel assignment of the controller 53 on receipt of the channel assignment request message. Based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts, by channel assignment messages, the slot S1 of the channel M+1 to the individual base station 52C and the slot S2 of the channel M+1 to the individual base station 52E as shown in Fig. 14(b). Accordingly, the individual base station 52C posts the slot S1 of the channel M+1 to the radio terminal C (51C), and the individual base station 52E posts the slot S2 of the channel M+1 to the radio terminal E (51E). As a result, although the transmission speed of the radio terminal C (5C) decreases, the radio terminal G (5G) can communicate, and the slot S3 of the channel M+1 becomes unassigned.
12. When no channels are available (when slots assigned to the radio terminal C (51C) are assigned to another radio terminal as required):

In the case where all the slots S1, S2 and S3 of the channel M are set as radio channels for the radio terminals A (51A), B (51B) and D (51D) and all the slots S1 to S3 of the channel M+1 are set as a radio channel for the radio terminal C (51C) as depicted in Fig. 15(a), if the radio terminal E (51E) (not shown) sends a radio channel assignment message, then the individual base station 52E having received the channel assignment request mes-

sage requests a channel assignment of the controller 53, and based on the channel assignment status stored in the channel assignment monitor 54, the controller 53 posts, by channel assignment messages, the slots S1 and S2 of the channel M+1 to the individual base station 52C and the slot S3 of the channel M+1 to the individual base station 52E as shown in Fig. 15(b). Accordingly, the individual base station 52C posts the slots S1 and S2 of the channel M+1 to the radio terminal C (51C), and the individual base station 52E posts the slot S3 of the channel M+1 to the radio terminal E (51E). As a result, the transmission speed of the radio terminal C (51C) decreases, but the radio terminal E (51E) is allowed to carry out communication.
13. Fragmented unassigned channels are gathered together:

When the slots S1 and S3 of the channel M are set for the radio terminals A (51A) and C (51C) and the slot S2 of the channel M+1 for the radio terminal B (51B), as shown in Fig. 16(a), the individual base station 52B sends a radio channel assignment message to the radio terminal B (51B) to assign the slot S2 of the channels M as depicted in Fig. 16(b). As a result, the unassigned channels can be gathered together without inhibiting communication.

[0041] As described above, the assignment of radio channels between radio terminals and a base station can be changed by sending an assignment permission message from the base station side to the radio terminal side in response to a channel assignment change request from the latter to the former as shown in Fig. 17, or by sending an assignment permission message from the radio terminal side to the base station side in response to a channel assignment change request from the latter to the former as depicted in Fig. 18.

EMBODIMENT 3

[0042] In the above embodiments channel assignment is varied depending on the amount of communication data. However varying channel assignment with the rate of change of communication data per unit time also allows effective use of a limited number of channels, speeds up data communication and reduces inefficient use of channels.

EMBODIMENT 4

[0043] When the radio terminal A moves out of the radio zone of the base station 1 where it has carried out communication so far and into the radio zone of the other base station 2 in Fig. 1 (hand-over), it is possible to speed up data communication and reduce inefficient use of channels by posting the number of radio channels assigned to the radio terminal A up to that point to

the base station upon occurrence of the hand-over.

INDUSTRIAL APPLICABILITY

[0044] As described above, the radio channel assignment method according to the present invention changes channel assignments in response to variation in the amount of communication data per unit time. Hence it permits speeding up data communication and reducing inefficient use of channels by effectively using a limited number of channels.

[0045] Furthermore, when a hand-over occurs, the number of channels used between the radio terminal concerned and the previous base station is posted to the new base station. In this way, it is possible to speed up data communication between the new base station and the radio terminal and reduce inefficient use of channels.

Claims

1. A radio channel assignment method for radio communications between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that the number of channels between each said radio terminal and said base station is changed in response to an amount of communication data therebetween.

2. The radio channel assignment method for radio communication according to claim 1, characterized in that when an amount of communication data is smaller than a preset reference value, one radio channel is assigned, and that when the amount of communication data is larger than a preset reference value, a plurality of adjacent radio channels are assigned.

3. The radio channel assignment method for radio communication according to claim 2, characterized in that when an amount of communication data is larger than a preset reference value, a plurality of available radio channels are assigned.

4. The radio channel assignment method for radio communication according to claim 2, characterized in that a base station sends a radio channel assignment message to a radio terminal to assign a plurality of consecutive available radio channels to said radio terminal.

5. The radio channel assignment method for radio communication according to claim 2, characterized in that a radio terminal sends a radio channel assignment message to a base station to assign a plurality of consecutive available radio channels to said radio terminal.

6. The radio channel assignment method for radio communication according to claim 1, characterized in that a radio terminal which requires a plurality of consecutive available radio channels assigns another radio terminal which has been assigned the channel which it requires to a different radio channel.

7. The radio channel assignment method for radio communication according to claim 6, characterized in that a base station sends a message to a radio terminal assigned a radio channel which is required by another radio terminal so that the radio terminal to which the channel had been assigned is assigned a different radio channel.

8. The radio channel assignment method for radio communication according to claim 6, characterized in that a radio terminal sends a radio channel assignment request message to a base station, and said base station sends a message to another radio terminal which is assigned a radio channel required by the radio terminal in order to assign a different radio channel to the other radio terminal.

9. The radio channel assignment method for radio communication according to claim 1, characterized in that when a radio terminal is added to a radio channel, the number of radio channels assigned to a certain radio terminal is decreased to make one of them unassigned.

10. The radio channel assignment method for radio communication according to claim 2, characterized in that a radio channel made unassigned by changing the radio channel assignment is assigned to a radio terminal required to carry out communication over a plurality of radio channels.

11. The radio channel assignment method for radio communication according to any one of claims 1 to 10, characterized in that radio channels connected between radio terminals and a base station are frequency division multiple access channels.

12. The radio channel assignment method for radio communication according to any one of claims 1 to 10, characterized in that radio channels between radio terminals and a base station are time division multiple access channels.

13. A radio channel assignment method for radio communication between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that said base station determines a number of channels to be assigned according to the rate of increase of stored data per unit time.

14. A radio channel assignment method for radio communication between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that said radio terminals each determine a number of channels to be assigned according to the rate of increase of stored data per unit time.

15. A radio channel assignment method for radio communication between a base station and a plurality of radio terminals in the radio zone of said base station, characterized in that said base station transmits, upon occurrence of a hand-over, a number of assigned channels to said base station with which the radio terminal newly communicates.
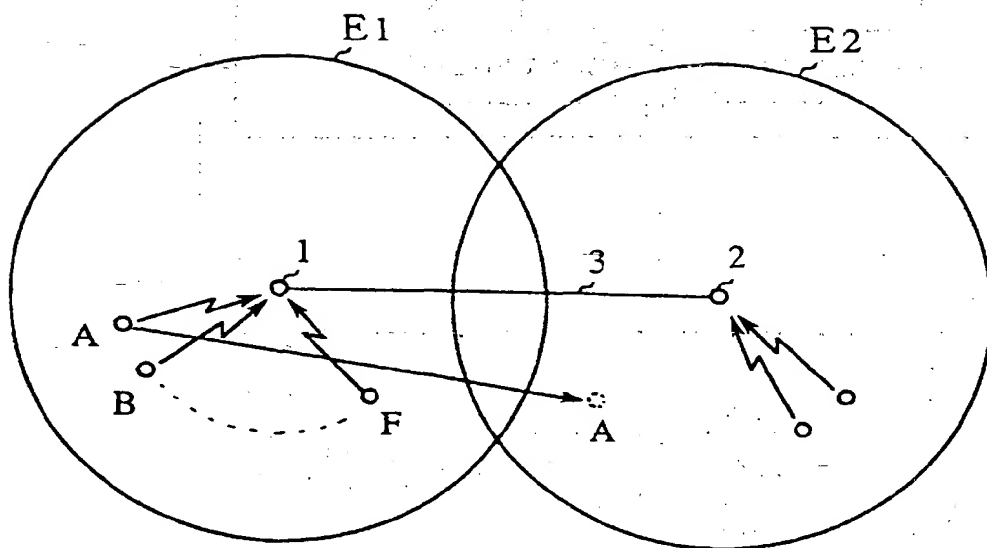
FIG.1

E1   E2

1   3   2

A

B   F   A

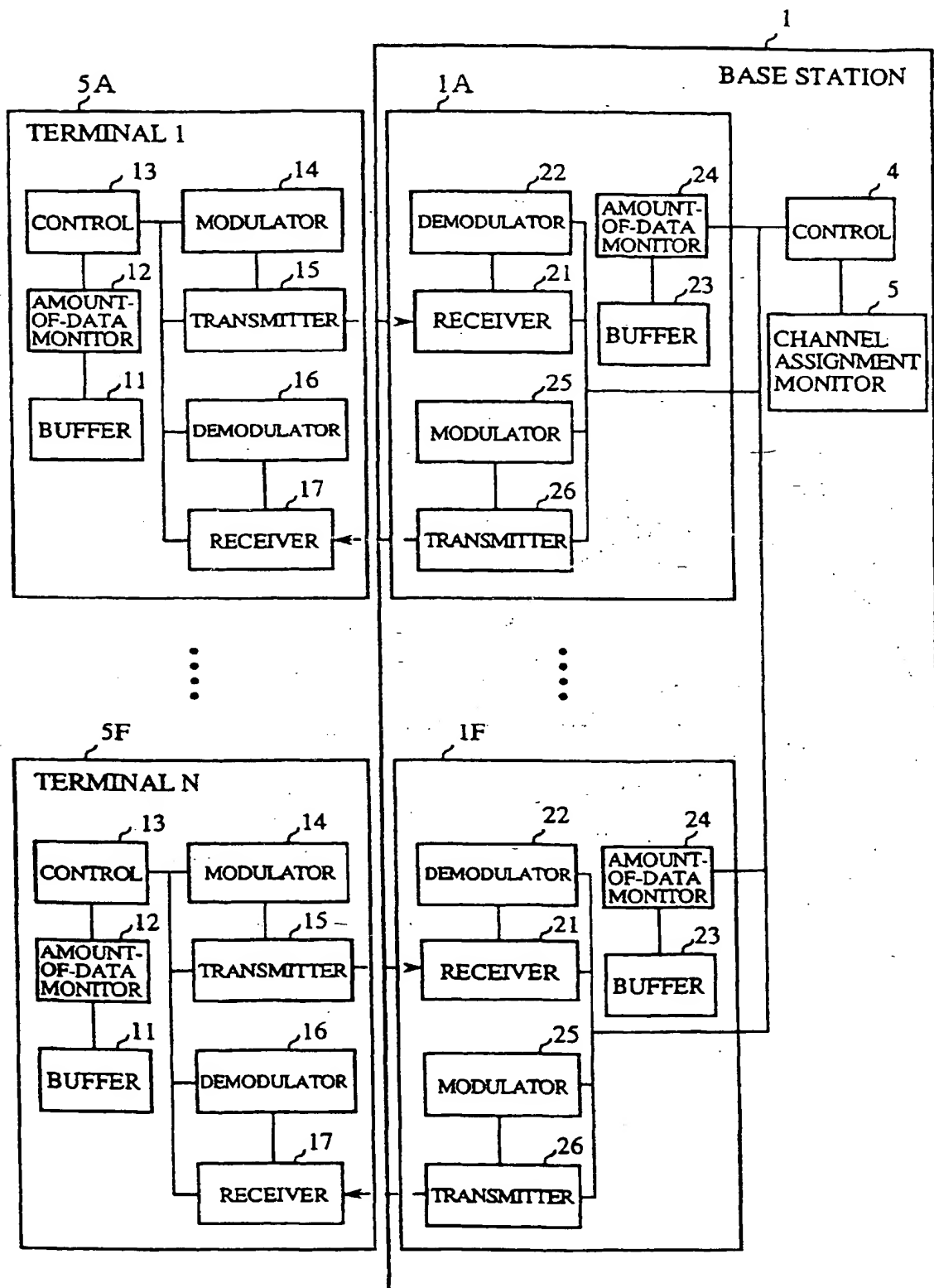# FIG.2

FIG.3(A)

CHANNEL M	UNASSIGNED
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	UNASSIGNED
CHANNEL M+3	UNASSIGNED

FIG.3(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	USED BY TERMINAL A
CHANNEL M+3	UNASSIGNED

FIG.4(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	USED BY TERMINAL A
CHANNEL M+3	UNASSIGNED

FIG.4(B)

CHANNEL M	UNASSIGNED
CHANNEL M+1	USED BY TERMINAL A
CHANNEL M+2	UNASSIGNED
CHANNEL M+3	UNASSIGNED

FIG.5(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL D

. . . . .

CHANNEL N	UNASSIGNED
CHANNEL N+1	UNASSIGNED
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED
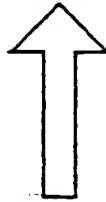
FIG.5(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	UNASSIGNED
CHANNEL M+3	USED BY TERMINAL D
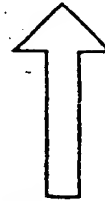
. . . . .

CHANNEL N	USED BY TERMINAL C
CHANNEL N+1	USED BY TERMINAL C
CHANNEL N+2	USED BY TERMINAL C
CHANNEL N+3	UNASSIGNED

FIG.6(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL D

. . . . .

CHANNEL N	UNASSIGNED
CHANNEL N+1	UNASSIGNED
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED

FIG.6(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL C
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL C

. . . . .
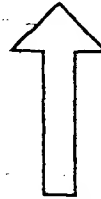
CHANNEL N	USED BY TERMINAL B
CHANNEL N+1	USED BY TERMINAL D
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED

FIG.7(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL E
CHANNEL M+3	USED BY TERMINAL D

. . . . .

CHANNEL N	USED BY TERMINAL C
CHANNEL N+1	USED BY TERMINAL C
CHANNEL N+2	USED BY TERMINAL C
CHANNEL N+3	USED BY TERMINAL F

FIG.7(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL E
CHANNEL M+3	USED BY TERMINAL D

. . . . .
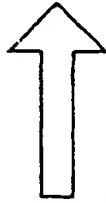
CHANNEL N	USED BY TERMINAL C
CHANNEL N+1	USED BY TERMINAL G
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	USED BY TERMINAL F

FIG.8(B)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	USED BY TERMINAL B
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	USED BY TERMINAL D

. . . . .
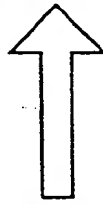
CHANNEL N	UNASSIGNED
CHANNEL N+1	UNASSIGNED
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	UNASSIGNED
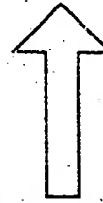
FIG.8(A)

CHANNEL M	USED BY TERMINAL A
CHANNEL M+1	UNASSIGNED
CHANNEL M+2	USED BY TERMINAL C
CHANNEL M+3	UNASSIGNED

. . . . .

CHANNEL N	UNASSIGNED
CHANNEL N+1	USED BY TERMINAL B
CHANNEL N+2	UNASSIGNED
CHANNEL N+3	USED BY TERMINAL D

FIG.9
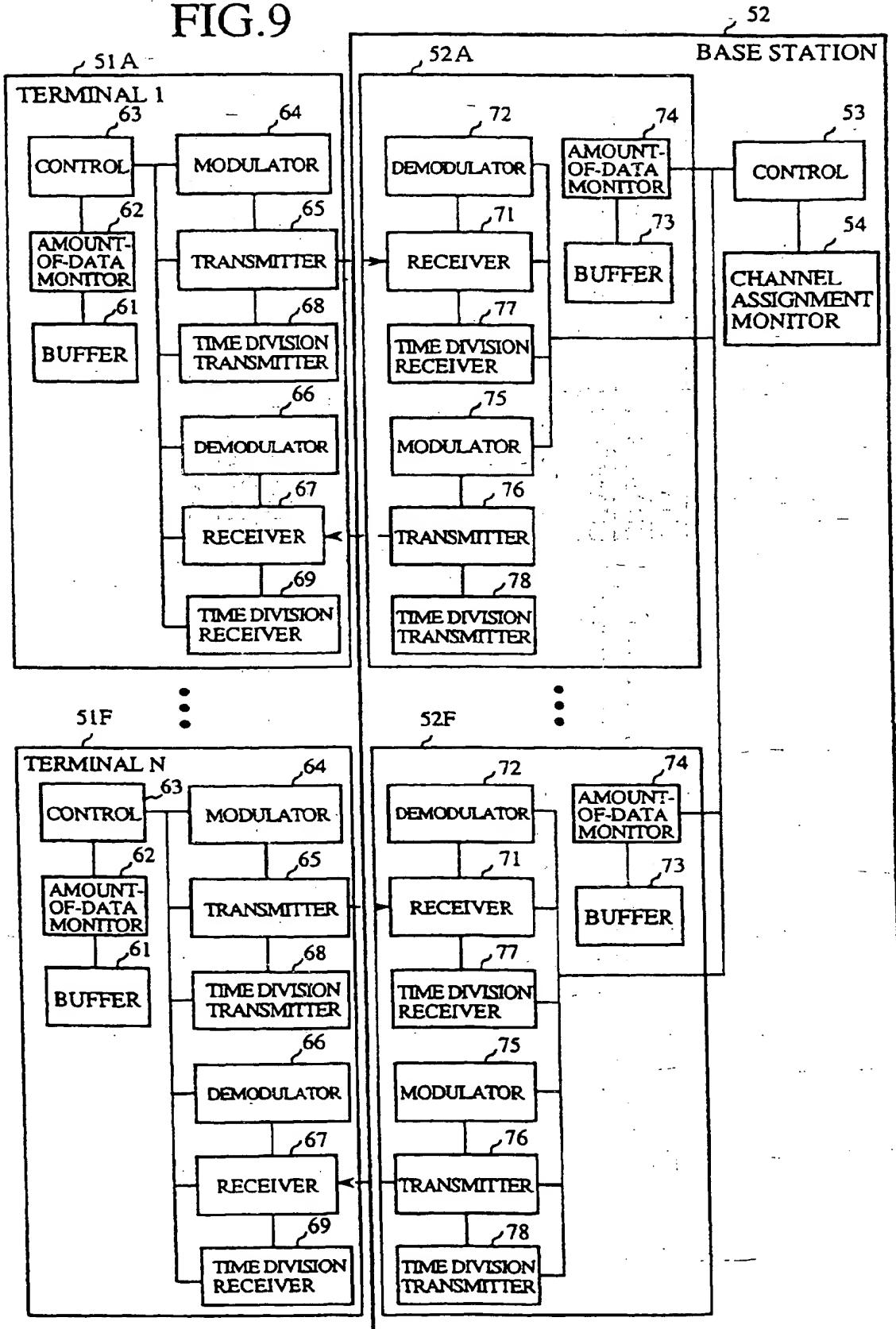
FIG.10(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

⇒

FIG.10(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	A	A	A	A	A	A	A	A
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.11(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	A	A	A	A	A	A	A	A
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

⇒

FIG.11(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED	A	UNASSIGNED	UNASSIGNED
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.12(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	C	A	B	C	A	B	C
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

⇩

FIG.12(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	UNASSIGNED	A	B	UNASSIGNED	A	B	UNASSIGNED
CHANNEL M+1	C	C	C	C	C	C	C	C	C

FIG.13(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	C	A	B	C	A	B	C
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED	UNASSIGNED

⇩

FIG.13(B)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	C	C	C	C	C	C	C	C	C
CHANNEL M+1	A	B	UNASSIGNED	A	B	UNASSIGNED	A	D	UNASSIGNED

FIG.14(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M		A	B	D	A	B	D		
CHANNEL M+1		C	C	C	C	C	C		

⇩

FIG.14(B)

	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D
CHANNEL M+1	C	E	UNASSIGNED	C	E	UNASSIGNED

FIG.15(A)

	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D			
CHANNEL M+1	C	C	C	C	C	C			

⇧

FIG.15(B)

	S1	S2	S3	S1	S2	S3
CHANNEL M	A	B	D	A	B	D
CHANNEL M+1	C	C	E	C	C	E

FIG.16(A)

	S1	S2	S3
CHANNEL M	A	UNASSIGNED	C
CHANNEL M+1	UNASSIGNED	B	UNASSIGNED

⇩

FIG.16(B)

	S1	S2	S3
CHANNEL M	A	B	C
CHANNEL M+1	UNASSIGNED	UNASSIGNED	UNASSIGNED

FIG.17

TERMINAL   BASE STATION

LARGER THAN
THRESHOLD

ASSIGNMENT REQUEST
MESSAGE

ASSIGNMENT PERMISSION
MESSAGE

FIG.18

TERMINAL   BASE STATION

ASSIGNMENT NOTIFICATION
MESSAGE

LARGER THAN
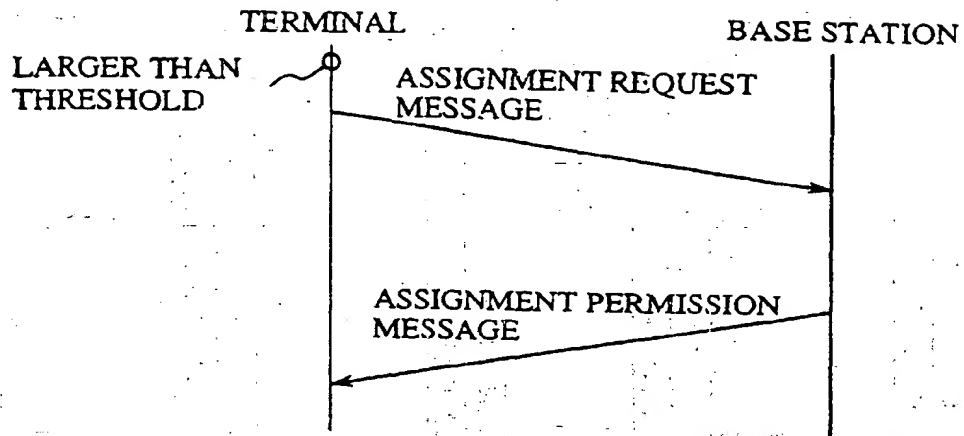THRESHOLD
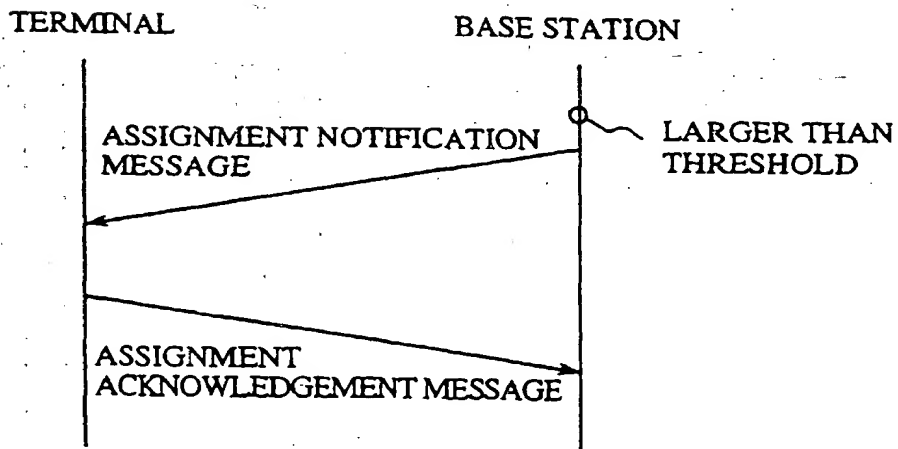
ASSIGNMENT
ACKNOWLEDGEMENT MESSAGE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/04644

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl⁶ H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl⁶ H04B7/26, H04Q7/00-7/38, H04J1/00-3/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho   1926-1998   Toroku Jitsuyo Shinan Koho   1994-1998
Kokai Jitsuyo Shinan Koho   1971-1998

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 6-77886, A (Fujitsu Ltd.), March 18, 1994 (18. 03. 94) (Family: none)	1, 4, 5, 9, 12
X	JP, 7-231479, A (Matsushita Electric Industrial Co., Ltd.), August 29, 1995 (29. 08. 95) (Family: none)	1-5, 9, 12, 15
X	JP, 9-65414, A (NEC Corp.), March 7, 1997 (07. 03. 97) (Family: none)	1, 11

☐ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
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"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		
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"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
March 9, 1998 (09. 03. 98)	March 17, 1998 (17. 03. 98)

Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)